

## **Workshop on Advancing Atmospheric Chemistry Through the Use of Satellite Observations from the Cross-track Infrared Sounder (CrIS)**

**PI:** Matthew Alvarado, Staff Scientist, Atmospheric and Environmental Research, Inc. (AER)

**Period:** 08/01/2014 – 02/28/2015    **Location:** College Park, MD

**Purpose:** The purpose of this meeting will be to identify current and potential uses of satellite observations from the Cross-track Infrared Sounder (CrIS) in both research and operational applications focused on atmospheric chemistry, air quality, the terrestrial carbon and nitrogen cycles, and climate. While retrievals of trace gases from thermal infrared (TIR) satellite observations from instruments such as TES, AIRS, MOPITT, and IASI have been widely used by the scientific community, the use of trace gas products derived from satellite data and their benefits to NOAA research and operations require more attention. Currently there is little interaction between the CrIS retrieval development community and the potential scientific and operational users (e.g., the NOAA air quality forecast team) of these retrievals products. In addition, the CrIS trace gas retrieval products currently produced by the NESDIS NUCAPS algorithm need further validation and refinement in order to maximize their usefulness in research studies and operational applications. A small workshop will facilitate interactive discussion, often lost in big meetings, which will: 1) identify users and applications for both current and potential future CrIS trace gas retrieval products; 2) identify the validation needs of these products; 3) identify any needed product changes and refinements; 4) develop a tentative design of validation field campaigns for CrIS trace gas products; and 5) enhance coordination and collaboration among the CrIS retrieval algorithm development community and the scientific and operational end users. The meeting will be summarized in a white paper for distribution to relevant program managers at NOAA and other interested funding agencies, as well as an opinion piece that will be submitted to the AGU EOS Transactions newsletter.

**Motivation:** The scientific communities studying atmospheric chemistry, air quality, carbon cycle, nitrogen cycle, and climate change extensively use trace gas retrievals from TIR satellite observations (e.g., Zhang et al., 2006; Logan et al., 2008; Jones et al., 2009; Bowman et al., 2009; Kopacz et al., 2010; Heald et al., 2012; Wecht et al., 2012; Wells et al., 2012; Crevoisier et al., 2013; Worden et al., 2013a,b; Zhu et al., 2013). These products have been provided by NASA Earth Observing System (EOS) instruments, such as the Tropospheric Emission Spectrometer (TES), the Atmospheric Infrared Sounder (AIRS), and the Measurements of Pollution In The Troposphere (MOPITT) instrument, as well as the Infrared Atmospheric Sounding Interferometer (IASI) aboard the EUMETSAT MetOp satellites. However, all of the EOS TIR sounders are currently well past their expected design lifetimes, and NASA does not have current plans to replace these instruments, which would lead to the loss of these critical data products and substantially harm scientific studies that depends on these products. Fortunately, the CrIS instrument, a Fourier Transform Infrared (FTIR) spectrometer currently flying on board the joint NOAA, NASA and DOD Suomi National Polar-orbiting Partnership (Suomi NPP) satellite, has the potential to continue many of these trace gas data records (Strow et al., 2013; Bowman et al., 2011). As CrIS will also be flown aboard the upcoming NOAA JPSS satellites, it has the potential to continue to produce TIR trace gas retrievals throughout the coming decade and beyond.

However, there are currently several limitations preventing the use of CrIS trace gas products by

the atmospheric science and operational application end users. First, there needs to be improved communication and collaboration between the CrIS retrieval communities at NESDIS and elsewhere and the potential end users of the trace gas retrieval products, particular users in NOAA. Second, there is a need for a coordinated strategy to validate trace gas products from CrIS and to identify any needed changes and improvements to the current CrIS trace gas products to facilitate their use by scientific and operational end users. Third, there is a need to make clear to NOAA, NASA, NSF, and other agencies the importance of funding the needed retrieval algorithm and validation work to enable the use of these products. This workshop will address these needs by bringing together the retrieval algorithm, scientific, and operational communities working with TIR trace gas retrievals to develop a strategic plan for the development, validation, dissemination, and use of CrIS trace gas products.

**Supplemental Keywords:** Infrared Satellite Retrievals, Trace Gases, Greenhouse Gases (GHGs), CrIS, IASI, TES, AIRS, MOPITT, Suomi NPP, Carbon Monoxide (CO), Ammonia (NH<sub>3</sub>), Methane (CH<sub>4</sub>), Ozone (O<sub>3</sub>), Nitrous Oxide (N<sub>2</sub>O), Nitric Acid (HNO<sub>3</sub>), Methanol (CH<sub>3</sub>OH), Peroxy Acetyl Nitrate (PAN), Carbonyl Sulfide (OCS)

**Objectives:** 1) Conduct a small workshop (roughly 25-30 invited participants) that will facilitate collaboration and the exchange of knowledge between the CrIS retrieval algorithm community and the atmospheric chemistry and carbon and nitrogen cycle science communities currently using trace gas products from other TIR satellite instruments; 2) Identify users and applications for both current and potential future CrIS trace gas retrieval products; 3) Identify the validation needs for these products and develop a strategic plan for addressing them; 4) Identify other limitations in the current products (e.g., all gases currently provided in one large file, averaging kernel and other error estimates not commonly provided) and a plan for addressing them; and 5) Disseminate workshop findings and results in the form of a white paper and an opinion piece for publication in EOS Transactions.

**Expected Results:** 1) A community-based manuscript lead by the PIs that will identify users and applications for both current and potential future CrIS trace gas retrieval products, identify the validation needs of these products, and identify any needed product changes and refinements; 2) a strategic plan and tentative design of validation field campaigns for CrIS trace gas products; and 3) coordination of future research among the various members of the CrIS retrieval algorithm and scientific and operational user communities.

**Recent Similar Meetings:** STAR JPSS Annual Science Team Meeting, May 12-16, 2014, College Park, MD; NASA Science Community Workshop on Polar Orbiting IR and MW Sounders, Nov. 1-2, 2010, Greenbelt, MD.

**Workshop Need:** At present, there is little interaction between the communities working on CrIS retrievals of trace gases and the air quality, atmospheric chemistry, and carbon and nitrogen cycle science communities. This workshop will be critical in forging connections between these communities and establishing a clear plan that will enable the use of CrIS data in scientific studies and operational applications. The venue at large meetings such as AGU or at meetings focused on individual field campaigns (e.g, SAS/SENEX) is unsuitable for these discussions as the focus of those meetings is on presenting research results rather than forming an action plan for the use of CrIS on idea exchange between the research communities or on. In order to get the

conversation moving quickly, a “trial balloon” draft of the action plan will be sent to all participants prior to the workshop so that they can come to the meeting with their questions, comments, suggestions, and objections already in mind.

***Chairpersons and Organizing Committee:***

**Matthew Alvarado**, AER; **Monika Kopacz** and **Kenneth Mooney**, NOAA Climate Program Office; **Mitch Goldberg**, JPSS Program Scientist

***Meeting Organization and Recruitment:***

The meeting will be held in College Park, MD, most likely at NOAA to minimize cost and increase the participation of NESDIS and NOAA ARL personnel. Participation in the workshop will be predominately by invitation and the travel expenses and lodging of those invited will be covered through their current funding or by this grant in cases of demonstrated need. Potential invitees will be selected by the PIs and the steering committee, and a preliminary list is attached below. Our selection process will ensure that the group of participants is sufficiently diverse: intellectual diversity criteria will include a sufficient number of participants from the TIR retrieval algorithm, field study, and modeling communities. Other diversity criteria will include career stage (early career vs. senior scientists) and underrepresented groups (i.e. gender and race). Given the small number of participants it will be difficult to perfectly balance all of these criteria but we will be cognizant of our diversity goals.

***Plans for management and sharing of any data products resulting from the activity:***

All data/information that is collected during this activity will be saved and made available to the public through the NOAA CPO website. Key findings will be presented in the summary report and an editorial that will be submitted for publication in EOS.

**Workshop agenda:**

Day 1: Morning – Participants travel to College Park, MD

- 1:00 : Presentation by the PIs of workshop goals, draft report
- 1:30-3:30: 12+3 min presentations by workshop participants on CrIS Retrievals
- 3:30-4:00: Coffee break
- 4:00-6:00: 12+3 min presentations on the use of TIR Retrievals in Atm. Chemistry and Climate studies
- 6:00-7:00: Poster session for presentations that couldn't fit in oral sessions
- 7:00 : Welcome reception/Dinner/Ice Breaker

Day 2: 8 am: Breakfast

- 8:30-9:00: Outline of charge to breakout groups:
  - (a) ID users and applications
  - (b) Describe status of current CrIS products
  - (c) ID validation needs
  - (d) ID needed product changes/refinements
- 9:00-10:30: Breakout Sessions
  - (a) Greenhouse Gases (CH<sub>4</sub>, CO<sub>2</sub>, N<sub>2</sub>O)

- (b) Air Quality (CO, O<sub>3</sub>, NH<sub>3</sub>, PAN)
- (c) Other Current Products (CH<sub>3</sub>OH, OCS, HNO<sub>3</sub>, HDO)
- (d) Future Products (HCN, C<sub>2</sub>H<sub>2</sub>, HCOOH, Acetone, Acetic Acid, etc.?)

10:30-11:00: Coffee break

11:00-12:00: 12+3 min reports by breakout groups

12:00-1:00 Box lunch

1:00-3:00: Chair led discussion of breakout group reports and draft report for NOAA

3:00-3:30: Coffee break

3:30-4:30: Finish discussion, assign action items

4:30: Adjourn

### **Invited Presentation/Participants (meeting will be open to all)**

1. NOAA NESDIS
  - a. Chris Barnet
  - b. Antonia Gambacorta
  - c. Quanhua (Mark) Liu
  - d. Nick Nalli
  - e. Awdhesh Sharma
  - f. Walter Wolf
  - g. Xiaozhen (Shawn) Xiong
2. Extramural PIs
  - a. Kevin Bowman (JPL/CalTech)
  - b. Louisa Emmons (NCAR)
  - c. Emily Fischer (Colorado State University)
  - d. Colette Heald (MIT)
  - e. Daven Henze (University of Colorado)
  - f. Dylan Jones (University of Toronto)
  - g. Jingqiu Mao (NOAA GFDL)
  - h. Dylan Millet (University of Minnesota)
  - i. Eri Saikawa (Emory University)
3. TIR retrieval folks
  - a. Karen Cady-Pereira (AER)
  - b. Hank Revercomb (UW-SSEC)
  - c. Juying Warner (University of Maryland – College Park)
  - d. Helen Worden (NCAR)
4. NOAA End Users
  - a. John Dunne (NOAA GFDL Biogeochem, Ecosystems, and Climate)
  - b. Larry Horowitz (NOAA GFDL Atm. Chem & Climate)

- c. Pius Lee (NOAA ARL AQ Forecasts)
  - d. Robert Pierce (NOAA NESDIS)
  - e. Michael Trainer (NOAA ESRL Regional Chemical Modeling)
  - f. Arlyn Andrews (NOAA ESRL Carbon Cycle and Greenhouse Gases)
5. Validation folks
- a. Jim Butler (Director, ESRL Global Monitoring Division)
  - b. David Fahey (Director, ESRL Chemical Sciences Division)
  - c. Joost de Gouw (NOAA ESRL/CIRES)
  - d. Andrew Neuman (NOAA ESRL/CIRES)
  - e. John Nowak (Aerodyne)
  - f. Colm Sweeney (NOAA ESRL/CIRES)

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